IN THE SPECIFICATION

Please replace paragraph [0003] with the following paragraph:

[0003]   Heat management systems for energy conversion devices oftentimes utilize fuels as cooling mediums, particularly on aircraft and other airborne systems where the use of ambient air as a heat sink results in significant performance penalties. In addition, the recovery of waste heat and its re-direction to the fuel stream to heat the fuel results in increased operating efficiency. One of the factors negatively affecting the usable cooling capacity of a particular fuel with regard to such a system is the rate of formation of undesirable oxidative reaction products and their deposit onto the surfaces of fuel system devices. The rate of formation of such products may be dependent at least in part on the amount of dissolved oxygen present within the fuel. The amount of dissolved oxygen present may be due to a variety of factors such as exposure of the fuel to air and more specifically the exposure of the fuel to air during fuel pumping operations. The presence of dissolved oxygen can result in the formation of ~~free radicals~~ hydroperoxides that, when heated, ~~propagate to form the~~ form free radicals that polymerize and form high molecular weight oxidative reaction products, which are typically insoluble in the fuel. Such products may be subsequently deposited within the fuel delivery and injection systems, as well as on the other surfaces, of the energy conversion device detrimentally affecting the performance and operation of the energy conversion device. Because the fuels used in energy conversion devices are typically hydrocarbon-based, the deposit comprises carbon and is generally referred to as "coke."

Please replace paragraph [0005] with the following paragraph:

[0005]   The present invention is directed in one aspect to a system for the management of thermal transfer in a gas turbine engine. Such a system includes a heat generating sub-system (or multiple sub-systems) disposed in operable communication with the engine, a fuel source configured to supply a fuel, a fuel stabilization unit configured to receive the fuel from the fuel source and to provide the fuel to the engine, and a heat exchanger disposed in thermal communication with the fuel to effect the transfer of heat from the heat generating sub-system to the fuel.

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Please replace paragraph **[0009]** with the following paragraph:

[0009]   In still another aspect, a system for the management of thermal transfer in an aircraft includes an aircraft engine, a heat generating sub-system (or multiple sub-systems) disposed in operable communication with the aircraft engine, a fuel source configured to supply a fuel, a fuel stabilization unit configured to receive the fuel from the fuel source and to provide an effluent fuel stream to the aircraft engine, and a heat exchanger disposed in thermal communication with the effluent fuel stream from the fuel stabilization unit and the heat generating sub-system to effect the transfer of heat from the heat generating sub-system to the effluent fuel stream.

Please replace paragraph **[0028]** with the following paragraph:

[0028]   The engine 14 is disposed in operable communication with the various heat generating sub-systems and preferably comprises a gas turbine engine having a compressor 30, a combustor 32, and [[an]] a turbine 34. Fuel from the fuel system 12 is injected into the combustor 32 through fuel injection nozzles 36 and ignited. An output shaft 38 of the engine 14 provides output power that drives a plurality of blades that propel the aircraft.

Please replace paragraph **[0029]** with the following paragraph:

[0029]   Operation of the system 10 with the FSU 16 allows for the control of heat generated by the various sources and systems to provide benefits and advantages as described above. The temperature at which coke [[forms]] begins to form in the fuel is about [[325]] 260 degrees F. Operation of the engine 14 (e.g., a gas turbine engine) at fuel temperatures of up to about 325 degrees F generally produces an amount of coke buildup that is acceptable for most military applications. Operation of the system 10 with the FSU 16 to obtain a reduction in oxygen content of the fuel, however, enables the engine 14 to be operated at fuel temperatures greater than about 325 degrees F, preferably greater than about 550 degrees F, and more preferably about 700 degrees F to about 800 degrees F with no significant coking effects. The upper limit of operation is about 900 degrees F, which is approximately the temperature at which the fuel pyrolizes.

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Please replace paragraph **[0032]** with the following paragraph:

[0032] The assembly of flow plates 27 is mounted within a vacuum housing 60. Vacuum is applied to the vacuum housing 60 to create an oxygen partial pressure differential across the permeable composite membranes 42, thereby causing the migration of dissolved oxygen from the fuel flowing through the assembly of flow plates 27 and to an oxygen outlet 35. The source of the partial pressure differential vacuum may be a vacuum pump, an oxygen-free circulating gas, or the like. In the case of an oxygen-free circulating gas, a ~~sparge~~ strip gas (e.g., nitrogen) is circulated through the FSU 16 to create the oxygen pressure differential to aspirate the oxygen from the fuel, and a sorbent or filter or the like is disposed within the circuit to remove the oxygen from the ~~sparge~~ strip gas.

Please replace paragraph **[0036]** with the following paragraph:

[0036] The permeable composite membrane 42 is defined by an amorphous fluoropolymer coating 48 supported on the porous backing 43. The fluoropolymer coating 48 preferably derives from a polytetrafluoroethylene (PTFE) family of coatings and is deposited on the porous backing 43 to a thickness of about 0.5 micrometers to about 20 micrometers, preferably about 2 micrometers to about 10 micrometers, and more preferably about [[4]] 2 micrometers to about 5 micrometers. The porous backing 43 preferably comprises a polyvinylidene difluoride (PVDF) or polyetherimide (PEI) substrate having a thickness of about 0.001inches to about 0.02 inches, preferably about 0.002 inches to about 0.01 inches, and more preferably about 0.005 inches. The porosity of the porous backing 43 is greater than about 40% open space and preferably greater than about 50% open space. The nominal pore size of the pores of the porous backing 43 is less than about 0.25 micrometers, preferably less than about 0.2 micrometers, and more preferably less than about 0.1 micrometers. ~~Polytetrafluoroethylene~~ Amorphous polytetrafluoroethylene is available under the trade name Teflon AF® from DuPont located in Wilmington, Delaware. Other fluoropolymers usable as the fluoropolymer coating 48 include, but are not limited to, perfluorinated glassy polymers and polyperfluorobutenyl vinyl ether. Polyvinylidene difluoride is available under the trade name Kynar® from Atofina Chemicals, Inc. located in Philadelphia, Pennsylvania.

Please replace paragraph **[0037]** with the following paragraph:

[0037] The porous substrate 39 comprises a lightweight plastic material (e.g., PVDF, PEI, polyethylene, or the like) that is compatible with hydrocarbon-based fuel. Such material is of a selected porosity that enables the applied vacuum to create a suitable oxygen partial pressure differential across the permeable composite membrane 42. The pore size, porosity, and thickness of the porous substrate 39 are determined by the oxygen mass flux requirement, which is a function of the mass flow rate of fuel. In a porous substrate 39 fabricated from polyethylene, the substrate is about 0.03 inches to about 0.09 inches in thickness, preferably about 0.04 inches to about 0.085 inches in thickness, and more preferably about 0.070 inches to about 0.080 inches in thickness. Alternatively, the porous substrate may comprise a woven plastic mesh or screen, a thinner and lighter vacuum permeate having a thickness of about 0.01 inches to about 0.03 inches.

Please replace paragraph **[0039]** with the following paragraph:

[0039] The baffles 52 disposed within the passages 50 promote mixing of the fuel such that significant portions of the fuel contact the fluoropolymer coating 48 during passage through the FSU 16 to allow for diffusion of dissolved oxygen from the fuel. Because increased pressure differentials ~~in the plate~~ across the passages are generally less advantageous than lower pressure differentials, the baffles 52 are preferably configured to provide laminar flow and, consequently, lower levels of mixing ~~by promoting laminar flow~~ (as opposed to turbulent flow) through the passages 50. Turbulent flow may, on the other hand, be preferred in spite of its attendant pressure drop when it provides the desired level of mixing and an acceptable pressure loss. Turbulent channel flow, although possessing a higher pressure drop than laminar flow, may promote sufficient mixing and enhanced oxygen transport such that the baffles may be reduced in size or number or eliminated altogether. The baffles 52 extend at least partially across the passages 50 relative to the direction of fuel flow to cause the fuel to mix and to contact the fluoropolymer coating 48 in a uniform manner while flowing through the flow plates 27.

Please replace paragraph **[0040]** with the following paragraph:

[0040] Referring to FIG. 5, in operation, fuel flowing through the passages 50 of the flow plate in the direction of the arrow 47 [[are]] is caused to mix by the

baffles 52 and contact the fluoropolymer coating 48. As shown, the baffles 52 are ~~alternatingly~~ <u>alternately</u> disposed at the upper and lower faces of the flow plate. In this embodiment, ~~fuel flowing over the baffles 52 is encouraged to mix such that the fuel more uniformly contacts the fluoropolymer coating 48 to provide for a more uniform diffusion through the porous backing 43 and into the porous substrate 39 and out of the FSU. The~~ <u>the</u> baffles 52 induce vertical (upwards and downwards) velocity components that enhance mass transport and effectively increase the oxygen diffusivity in the fuel. This increases the oxygen/fluoropolymer contact, and thus the amount of oxygen removed from the FSU. <u>Fuel flowing over the baffles 52 is encouraged to mix such that the fuel more uniformly contacts the fluoropolymer coating 48 to provide for a more uniform diffusion through the porous backing 43 and into the porous substrate 39 and out of the FSU.</u> Referring to FIG. 6, another embodiment of the flow plate is shown including baffles 52 arranged at one side of the flow plate. It should be understood that it is within the contemplation of this invention to include any configuration of baffles 52 <u>or mixing enhancers, including, but not limited to, inertial devices, mechanical devices, acoustic devices, or the like,</u> to induce either a turbulent flow regime or a laminar flow regime to attain the desired amount of mixing and/or mass transport according to application-specific parameters.

Please replace paragraph **[0043]** with the following paragraph:

[0043]   Performance of the FSU 16 is related to permeability of the permeable composite membrane 42 and the rate of diffusion of oxygen therethrough. The permeability of the permeable composite membrane 42 is a function of the solubility of oxygen in the fluoropolymer coating 48 and the transfer of the oxygen through the porous backing 43. The permeable composite membrane 42 (the combination of the fluoropolymer coating 48 and the porous backing 43) is of a selected thickness to allow for the desired diffusion of dissolved oxygen from the fuel to the porous substrate 39 for specific applications of vacuum or ~~sparge~~ <u>strip</u> gas (e.g., nitrogen).

Please replace paragraph **[0044]** with the following paragraph:

[0044]   The rate of diffusion of oxygen from the fuel through the surface of the permeable composite membrane 42 is affected by the duration of contact of fuel with the permeable composite membrane 42 and the partial pressure differential across

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the permeable composite membrane 42. It is desirable to maintain a steady application of vacuum on the FSU 16 and constant contact between the permeable composite membrane 42 and fuel in order to maximize the amount of oxygen removed from the fuel. Optimizing the diffusion of dissolved oxygen involves balancing the fuel flow, fuel temperature, <u>vacuum level,</u> and the amount of mixing/transport, as well as accounting for minimizing pressure loss and accounting for manufacturing tolerances and operating costs.

Please replace paragraph **[0048]** with the following paragraph:

[0048] The high temperature heat source 22 may further comprise a cooled turbine cooling air unit 80, as is shown with reference to FIG. 9. The cooled turbine cooling air unit 80 effects the heat transfer between the deoxygenated fuel from the FSU 16 and the engine 14 by receiving an air stream at a temperature of about 1,200 degrees F from the compressor 30 of the engine 14 and the deoxygenated fuel stream from the FSU 16. Heat is transferred between the received air stream and the fuel stream, thus heating the deoxygenated fuel and cooling the air. ~~The heated fuel is directed to the combustor 32, and the cooled air is directed to a compressor 39. The outlet stream from the compressor 39 is split into three streams and directed back to the compressor 30, the combustor 32, and the turbine 34.~~ The temperature of the heated fuel is greater than the coking limit of about 325 degrees F and less than the temperature at which pyrolysis occurs (about 900 degrees F). In particular, the temperature of the heated fuel is preferably about 700 degrees F to about 800 degrees F. <u>The heated fuel is directed to the combustor 32, and the cooled air is directed to a compressor 39. The low temperature outlet stream from the compressor 39 is split into three streams and directed back to the compressor 30, combustor 32, and the turbine 34.</u> Upon directing the cooled air to the <u>compressor 30, the combustor 32, and the</u> turbine 34, a buffer layer of cool air is received at the surfaces of ~~the turbine,~~ <u>these three components,</u> thereby allowing the <u>gases flowing</u> ~~combustion gases received from~~ <u>through the compressor 30,</u> the combustor 32<u>, and the turbine 34</u> to be of higher temperatures.

Please replace paragraph **[0049]** with the following paragraph:

[0049] The high temperature heat source 22 may comprise a turbine exhaust recuperator 86, as is shown with reference to FIG. 10. The turbine exhaust

recuperator 86 provides for the management of heat transfer by utilizing hot [[air]] gases exhausted from the turbine 34 to heat the fuel directed to the combustor 32. Upon operation of the turbine exhaust recuperator 86, turbine [[air]] exhaust at about 1,200 degrees F is directed to a heat exchanger 88 and used to heat the deoxygenated fuel received from the FSU 16. Upon such a heat exchange, cooled [[air]] exhaust is ejected from the heat exchanger 88. The heated fuel is directed to the combustor 32. The temperature of the fuel directed to the combustor 32 is at least about 550 degrees F, preferably about 550 degrees F to about 900 degrees F, and more preferably about 700 degrees F to about 800 degrees F.